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Fish Reactions to Trawl Gear — A Study Comparing Light and Heavy Ground Gear

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Fish Reactions to Trawl Gear — A Study Comparing Light and Heavy Ground Gear

J Main and G I Sangster

Marine Laboratory Aberdeen

Introduction

This paper describes how haddock, *Melanogrammus aeglefinus* (L.), saithe, *Pollachius virens* (L.) and mackerel, *Scomber scombrus* L. react to two types of bottom trawl, one with a lightly rigged grass footrope and the other a heavy bobbin groundline.

The observations were made using a diver-operated towed underwater vehicle, TUV II (Main & Sangster, 1978b, 1979, 1981a & b, 1982a & b) which enables scientists to position themselves and make observations of fishing gear at speeds up to 3m s^{-1} (6 knots).

A moving trawl provides a set of optical and acoustic stimuli which influence fish in various ways (Blaxter, Parrish & Dickson, 1964; Hemmings, 1966; Buerkle, 1967; Chapman & Hawkins, 1969; Chapman, 1970). However, fish possess a variety of sensory receptors that may perceive the presence or approach of the trawl. Their environment may change from light to dark which will determine visible range and how far the fish can see the approaching trawl stimulus (Anthony, 1981) and water temperature is one factor affecting speed and endurance in out-manoeuvreing the trawl (Wardle, 1976, 1977, 1983). Direct observations of fish reactions to towed gears allows us to predict in a general way what fish are likely to do when approached by a particular trawl gear (Hemmings, 1967, 1973; High, 1967; Korotkow, 1969; Sangster & Hemmings, 1971; Trillo, 1976; Korotkow & Martyschewski, 1977; Main & Sangster, 1978a, 1981a & b, 1982a & b).

The visual stimulus provided by a trawl gear depends on the colour and mesh size of the netting panels, and on the various bridles and ground gear employed. The audible stimulus depends on the roughness of the sea bed but is also greatly affected by the mounting of headline floats and the presence of bobbins, chains, etc in the ground gear. Seine nets or lightly rigged trawls are almost silent on a sandy sea bed (Hawkins & MacLennan, 1971) whereas heavy trawl ground gears can generate loud noises on sand or hard sea beds (Hawkins, MacLennan & Urquhart, 1972; Urquhart & Hawkins, 1976).

Materials and Methods

Experiments were conducted during 1981, in daylight, on fishing grounds (flat, sandy sea bed, depth 20-30m) near Lochinver, Scotland, using the commercial trawler "Aries" BCK 126 (230 hp, 20m). The trawls used were a "Cosalt" three bridle lightly rigged trawl and a "Boris Mystic" bobbin trawl, both commonly used by Scottish fishermen. The nets and their rigging are described in Figures 1 and 2. The trawl boards were steel rectangular Vee (1.8m x 1.1m) (Anon., 1974). The length of trawl warp between the ship and the otterboards was 137m. Towing speed was kept as near 1.5m s^{-1} (3 knots) as possible, using propeller speed logs on board ship and on the TUV II. These calibrated speed logs give an accuracy of ± 1% over their maximum range of 5m s^{-1}. Trawl board spread, wing end spread, and wing

end and headline heights were measured from the TUV II using a diver operated hand-held sonar unit. The techniques of observing fishing gears in action are described in detail by Main & Sangster (1978b, 1979, 1981a & b). The television pictures were obtained using a hand-held underwater camera with a 12.5mm RCA TC–125 silicon intensified target camera tube. This camera is as sensitive as the human eye and is particularly sensitive to green underwater natural light. A clock inserted on the video frame allows other data to be synchronised with the television picture. Still photographs were obtained using a Nikonos III underwater camera fitted either with a 15mm or 28mm lens. Ilford HP5 and Agfapan Vario-XL 35mm negative film rated at 800 ASA were used throughout the experiments using only natural light.

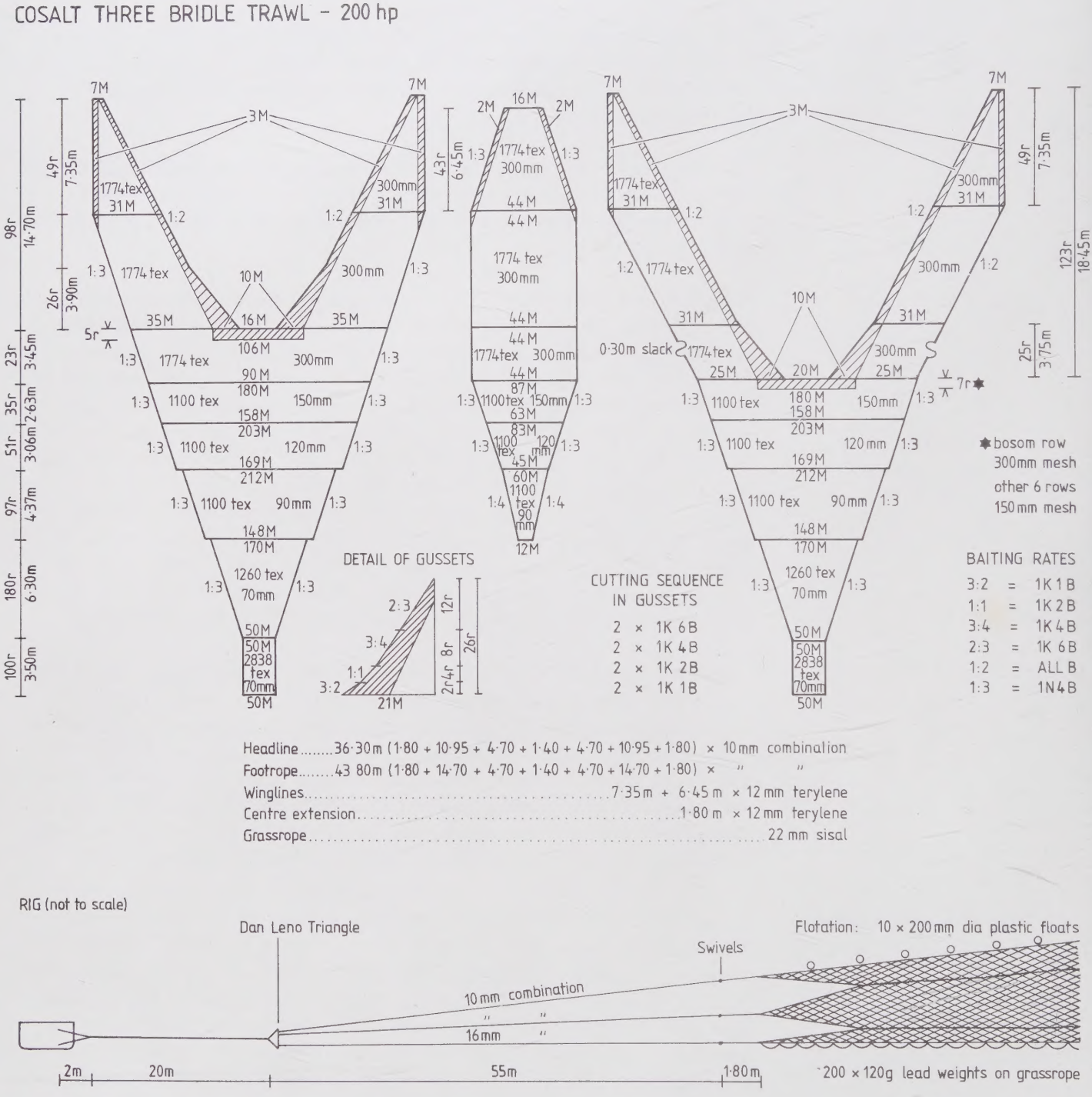

COSALT THREE BRIDLE TRAWL - 200 hp
DETAIL OF GUSSETS
CUTTING SEQUENCE IN GUSSETS
2 × 1K 6B
2 × 1K 4B
2 × 1K 2B
2 × 1K 1B
BAITING RATES
3:2 = 1K 1B
1:1 = 1K 2B
3:4 = 1K 4B
2:3 = 1K 6B
1:2 = ALL B
1:3 = 1N4B
✱bosom row 300mm mesh
other 6 rows 150mm mesh
Headline.....36·30m (1·80 + 10·95 + 4·70 + 1·40 + 4·70 + 10·95 + 1·80) × 10mm combination
Footrope.....43·80m (1·80 + 14·70 + 4·70 + 1·40 + 4·70 + 14·70 + 1·80) × " "
Winglines.....7·35m + 6·45m × 12mm terylene
Centre extension.....1·80m × 12mm terylene
Grassrope.....22mm sisal
RIG (not to scale)
Dan Leno Triangle
Swivels
Flotation: 10 × 200mm dia plastic floats
10mm combination
16mm
2m
20m
55m
1·80m
200 × 120g lead weights on grassrope

Figure 1. Net diagram and rigging specification for the "Cosalt" three bridle trawl.

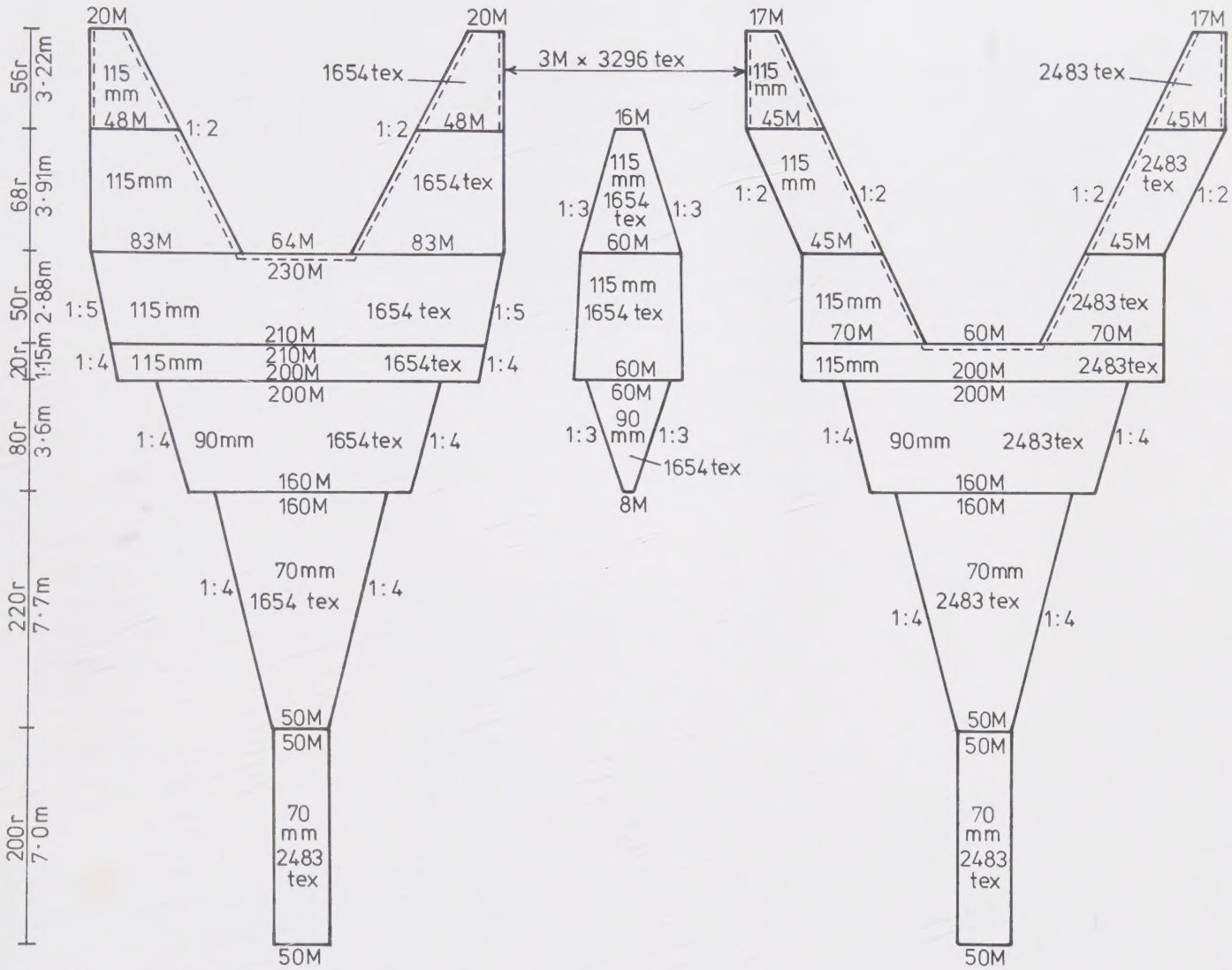
BORIS MYSTIC BOBBIN TRAWL (150 - 500 hp)

Flotation - 20 × 200mm floats

Groundrope - 9m × 90mm dia rubber discs

6m × 350mm rubber bunt bobbins + 450mm rubber wheel bobbins

BAITING RATES
1 : 2 = All bars
1 : 3 = 1N4B
1 : 4 = 1N2B
1 : 5 = 3N4B

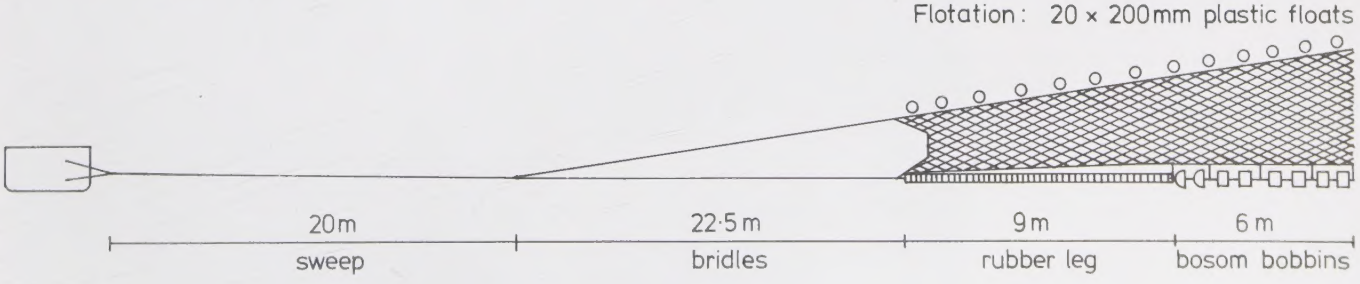


Headline - 18·9m (1·0 + 7·1 + 1·0) × 16mm pre-stretched terylene

Fishing lines - 25m (1 + 10 + 3 + 10 + 1) × 20mm polyethene + 24mm polyethene

Groundrope - 24m (9 + 6 + 9) Winglines - 7m × 16mm pre-stretched terylene

RIG (not to scale)



Bosom: 6m rubber wheels (350mm) Rubber leg: 9m rubber disc (90mm)

All on 12mm Drag Alloy Chain

Figure 2. Net diagram and rigging specification for the "Boris Mystic" bobbin trawl.

The contents of the cod-end were sampled and measured after each haul to obtain a size range for each fish species.

Results

The 11 hauls made with the "Cosalt" and 12 made with the "Boris Mystic" trawl were observed for total durations of approximately 310 minutes and 340 minutes, respectively. The towing speeds were between 1.4 and 1.6m s^{-1}.

Measurements of the Fishing Gears

The measurements obtained using the hand-held sonar unit are given in Table 1.

Table I

Fishing gear dimensions

Net Type	Trawl Board Spread	Wing end Spread	Headline Height	Wing end Height	Bridle Angle
"Cosalt" Three bridle light trawl	34.7 metres	9.1 metres	5.5 metres	4.2 metres	10^{o}
"Boris Mystic" bobbin trawl	31.1 metres	10.4 metres	4.6 metres	2.5 metres	12^{o}

Observations of the Fishing Gears

The sand clouds from the otterboards were similar in size and shape to those from the Vee board experiments described by Main & Sangster (1981b). The clouds passed 1-2m outside the wings of both trawls. On occasion, however, when "Aries" was not towing a straight course due to variations in wind direction and tide, the inner edges of the clouds alternated between 2m and 3m on either side of the wing tips.

Both gears had good contact with the flat sea bed from the otterboards to the bosom groundline, except that on one occasion when rigged with flying wings (Plate I) the "Boris Mystic" net was light at the quarters.

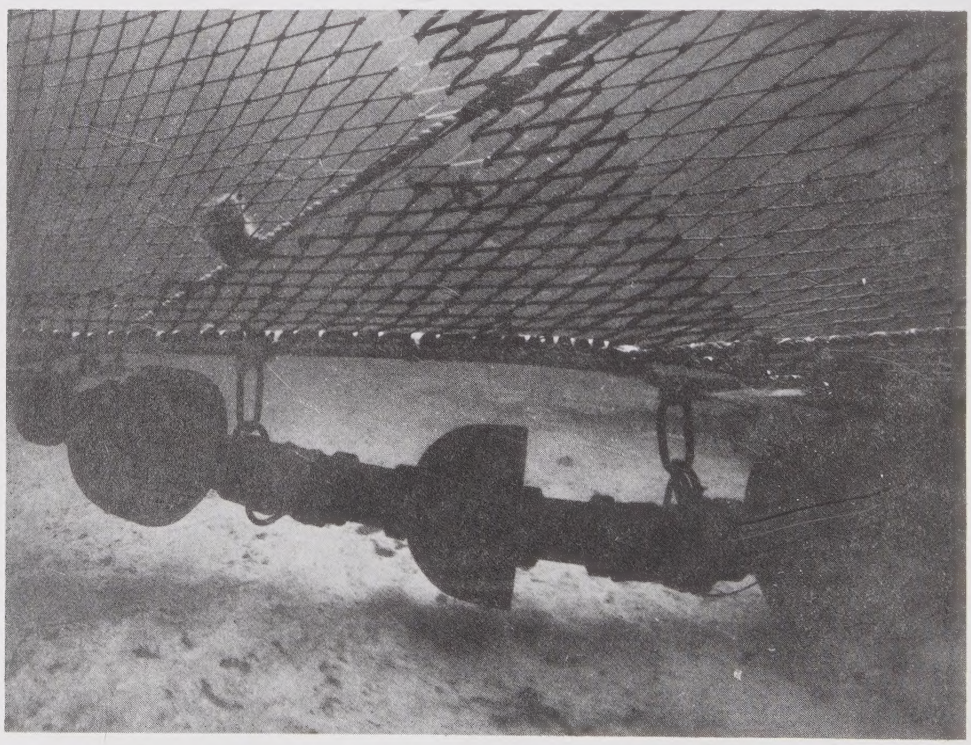


Plate I. View of the portside quarter area of the "Boris Mystic" trawl showing the half shape rubber bobbins lifting clear of the sea bed when the net was rigged with flying wings.

seen. The rear part of the belly panel of the "Cosalt" net however was slack and fish were frequently seen pressed on to these meshes. Sometimes the cod-ends would twist and turn slowly when well filled with fish. After two or three revolutions in one direction, the entrance to the cod-end was temporarily blocked preventing any fish from passing back into the cod-end. After approximately half a minute, the cod-end slowly unwound and the fish passed into the cod-end. This effect was not seen when the cod-end was almost empty. Previous direct observations have shown that there is a great deal of turbulence in the cod-end (Main & Sangster, 1981a), which probably accounts for this slow spinning effect.

Visual Comparison of the Nets by Divers

Both nets are constructed in orange polyethylene and under daylight conditions in 20-30m with underwater visibility to the human eye ranging from 5-15m, the netting panels in the front sections appeared greyish in colour and visually similar when seen from 2-3m above the sea bed. Looking back into the mouth of both nets from the wing area, the netting was virtually invisible against the grey sand cloud background. However, the joining rows of blue/green twine and the rope selvedges could be distinguished and appeared as white hoops and black lines respectively (Plate II). The light grass footrope of the "Cosalt" net was very faint in comparison to the heavy black rubber bunts and bobbin wheels of the "Boris Mystic" trawl (Plate III). Both could be seen from the wing ends but not from 5m ahead of this position. Sand rose higher from the heavy bobbin groundline than from the light footrope of the "Cosalt" net. Neither net could be seen from a position half way to the otterboards.

Plate II. A view into the mouth of the "Cosalt" trawl. The top and side panels are virtually invisible against the water background. The joining rows and selvedges appear as white loops and black lines, respectively.

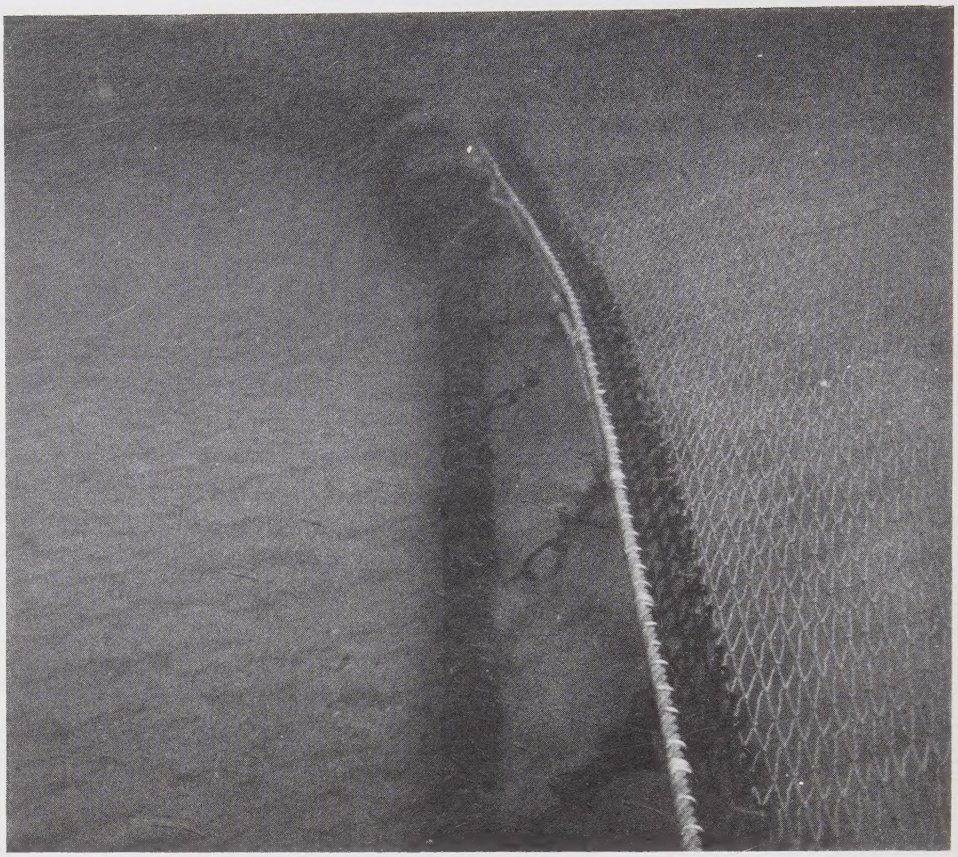


Plate III. **To the human eye, the black rubber disc bunts and rubber wheel bobbins of the "Boris Mystic" trawl present a considerable visual cue when seen from ahead**

Ship and Trawl Gear Noise

The sound of each gear was judged and compared by the divers from various points ahead of the net mouth. At the wing end position the "Cosalt" trawl was judged to be silent on the flat sand, whereas in comparison, the "Boris Mystic" was easily heard 10m ahead of the wing ends. The sounds heard were due to the chains, shackles and bobbins as they moved across the flat sandy sea bed. Some fishermen when rigging their gear tie their headline floats in groups, but in these nets they were spread out and did not knock together. From a distance of 2m the otterboards, sweeps and bridles were barely heard on the flat sand, but a certain "scraping" noise is produced by these components as they move across the bottom striking isolated pebbles etc (Main & Sangster, unpublished results).

The ship's engine noise was clearly heard at all times between the otterboards and at the net. The bobbin noise could not be heard by the divers at the otterboard area.

Fish Reactions to the "Cosalt" Trawl with no Bobbin Rig

Haddock (length 25-50cm) and saithe (length 27-46cm)

With the vehicle positioned at the otterboard, haddock and saithe were generally seen first both as small groups (10-20 fish) and large schools (more than 100 fish) close to the sea bed (1-2m), slowly swimming towards the net. These species were never seen to swim in the towing direction in this area, or to swim close to the otterboards. They swam in a region equidistant between the warps and sweeps. Observations at the wing end showed that the haddock and saithe continued on this path; they then swam straight back over the bosom groundline into the net (Plate IV) or turned in front of the footrope, close to the sea bed, to remain with the gear. Observing still further back, through the wing of the net, some other behaviour patterns were noted. On one occasion a group of 20-30 haddock (size range 34-45cm) were seen in the path of the approaching net feeding on

sandeels (*Ammodytes marinus* Raitt). As the footrope approached them they suddenly took up station with the net by swimming steadily forward close to the sea bed just ahead of the footrope. Similarly, on a number of occasions saithe were seen to feed on small sandeels both on the bottom and up to 1.5m above it (Plate V) and up to 5m ahead of the bosom groundline. A few saithe were hit by the groundrope while feeding on the bottom; one fish appeared stunned and another was run over by the light footrope. Normally, saithe avoided the sand clouds which occasionally came inside the wing ends of the net, but they were seen diving into the low sand clouds thrown up by the groundline to feed on small sandeels. Those haddock and saithe that swam straight into the net, turned 5-6m behind the footrope to swim forward within the net. At a towing speed of 1.5m s^{-1}, most saithe swam close to the belly meshes to a position near the footrope. Only the larger haddock (40-50cm) could sustain this effort and these only for a short time. If other fish (saithe, haddock or mackerel) were already swimming forward in the area in front of the footrope, their presence appeared to influence fish arriving later (both as individuals or groups of 20-30 fish) and cause them to turn earlier. On one occasion a large school of haddock (400-500 fish) was observed to turn between the wing ends and form a narrow column of fish in the centre of the net path (Plate VI) as described by Main & Sangster (1981b).

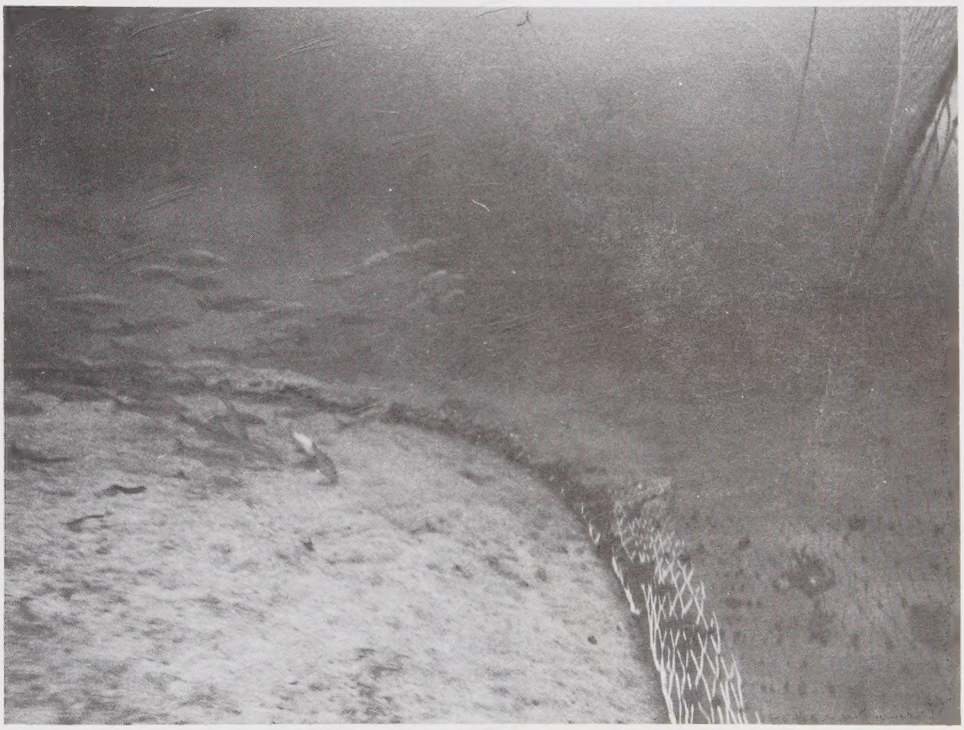


Plate IV. **Saithe swimming straight back over the footrope into the "Cosalt" trawl. A few are feeding on sandeels on the bottom.**

Plate V. Saithe between the wings of the "Cosalt" trawl feeding on sandeels on the sea bed. When the footrope approached, all fish eventually took up station to swim with the net.

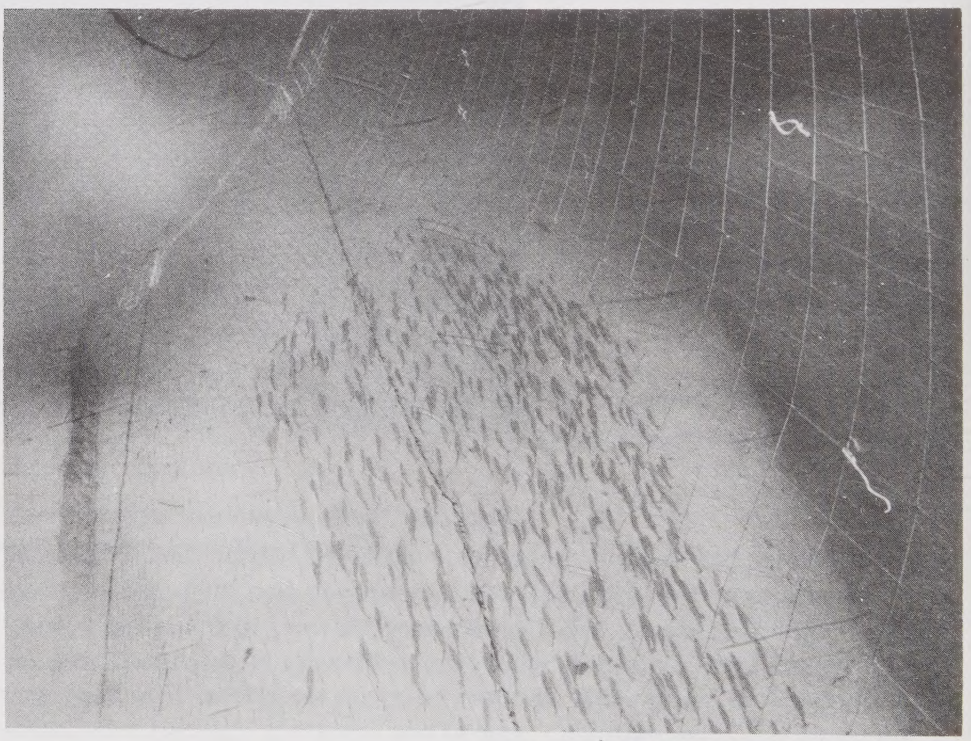


Plate VI. Through the netting of the port wing of the "Cosalt" trawl haddock are seen swimming in a column formation in the centre of the net path.

Haddock swimming ahead of the groundline slowly lost ground and eventually, after no more than two minutes, were in a position 1-2m ahead of the footrope bosom. These fish then showed a "kick and glide" swimming action to stay in front of the gear at 1.5m s^{-1}. No haddock maintained this speed for more than 2½ minutes before they tired. They then rose high off the sea bed (Plate VII), turned and slowly swam into the top part of the net. None was seen to escape over the headline. The detail of this typical behaviour is described by Main & Sangster (1981b).

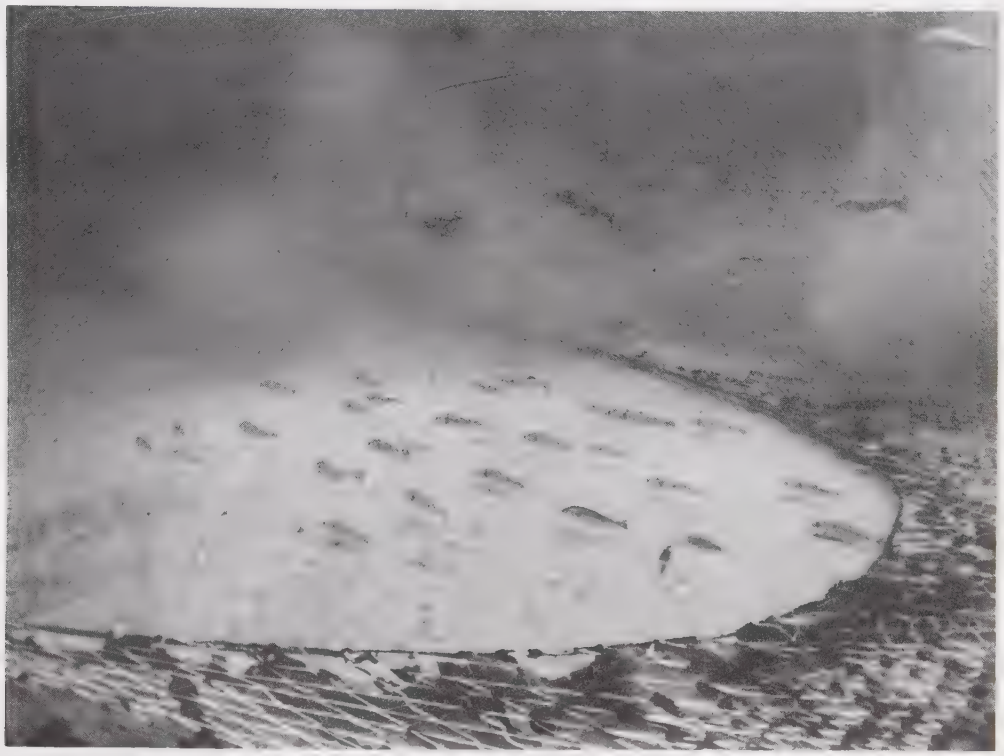


Plate VII. Haddock in the path of the "Cosalt" trawl. As they became tired or exhausted, they rose up from the sea bed before entering the net.

Saithe (size range 30-45cm), swam for longer periods ahead of the net mouth (approximately 15 minutes at 1.5m s^{-1}), then rose clear of the footrope and passed back into the net.

Further back in the funnel of the net many haddock and saithe turned and orientated themselves to swim forward again, but more slowly than the net, so they steadily lost ground and dropped back into the cod-end. Stomach analyses of haddock and saithe after completion of these hauls confirmed the presence of undigested sandeels (size range 11-13cm).

Mackerel (length 27-45cm) measured from catch sample

One group of mackerel was seen swimming 3-5m outside and ahead of the port otterboard. This school (approximately 100 fish) swam at right angles to the gear and into the path of the trawl both under and over the port trawl warp which was approximately 1m of the ground. They then swam directly away from the warp, close to the sea bed, and when equidistant between the trawl doors, turned and swam towards the advancing net. From near the starboard sweep wire, another large school (100-200 fish) was seen 2-3m inside and ahead of the starboard door. These fish turned and passed out under the starboard warp and swam away from the path of the gear. On both these occasions the mackerel swam fast (estimated 2-3m s^{-1}) using steady tail beat movements.

Small groups (5-10 fish) were also seen between the bridles, mixed with larger schools of haddock and saithe, swimming directly towards the net, close to the sea bed. Some swam straight back into the net, but others turned 4 or 5m ahead of the footrope, rose up from the bottom and formed a separate school above the haddock and saithe. This school moved around the mouth and inside the net and finally returned to a position, near the centre of the net mouth, close to the top panel, whence after a few minutes it moved forward out of the net. These mackerel swam past and through schools of saithe and haddock swimming ahead of the footrope. Then they increased their speed again and swam away between the wings, out of the gear. These mackerel did not return whilst these observations were being made. Of the few mackerel recovered from this net, most were meshed in the batings.

A mackerel (35-40cm) swimming among a school of saithe above the footrope was seen to swim quickly forward to catch a sandeel, lose it, dash forward again to take another, and then to steadily swim forward out of the trawl and escape. Towing speed at the time was 1.5m s^{-1}.

Fish Reactions to the "Boris Mystic" Trawl

Haddock (length 25-50cm) and saithe (length 27-46cm)

In the otterboard area these species behaved in a similar manner in small (5-10 fish) and large groups (100-200 fish). They swam slowly towards the approaching gear, equidistant between the boards. On four occasions just ahead of the boards, 20-30 saithe were seen close to the sea bed and feeding on the bottom. When the otterboards passed, they swam slowly towards the net, between the two sand clouds. These species never swam in the towing direction in the otterboard or bridle areas. Near the net itself, haddock and saithe again behaved similarly. Once level with the wing ends, most saithe turned to swim with the net; whilst a few swam out under the wingline, most kept well clear of the wings and close to the sea bed. During one observation period, a large number of saithe (approximately 100) swam back towards the net and passed out over the port sweep ahead of the bridles and into this corridor of clear water, swimming with the gear between the sand cloud and the wing of the net. The sand cloud was 3-4m outside the port wing end because the towing vessel had altered course slightly to starboard. The fish in the corridor had tired and dropped back outside the port bridle and were being held between the sand cloud and the net. During another period when the ship was manoeuvring, 50-60 haddock swam back close to the port sand cloud and entered the clear water corridor between the bridles and the sand cloud. Only a few were seen to pass under the wingline into the corridor. Haddock were never seen to enter a sand cloud but on one occasion a few swam up over it while others escaped by passing back along the outside of the net in the clear passage between the net and sand cloud. However, most haddock turned to swim with the gear 5-6m ahead of the bobbins but many turned as far as 5m ahead of the wing ends. On six occasions groups of haddock and saithe met the net at the height of the wing ends (wing end height 2.5m — Table I). All these fish turned forward and then slowly descended onto the sea-bed between the wings to keep station with the net. They spread out low across the path of the net, and other fish coming back from ahead of the gear turned and joined the front of the main school to form a narrow ribbon or column formation, equidistant between the wings (Plate VIII). No stacking of haddock was seen to occur at this position, even when an estimated 400-500 fish were swimming between the wings ahead of the bobbins. Saithe in this position also kept close to the sea bed, but when large numbers filled the area between the wings, they stacked up to a height of 1-2m, just above the haddock. At 1.5m s^{-1}, saithe swam for approximately 15 minutes before dropping back, whereas haddock swam for only 2-3 minutes, before they rose up out of the school to enter the net 3-4m above the bobbins (Plate IX).

On some occasions when the vehicle was outside the port quarter and the visible range was 10-15m, haddock were seen to rise from the sea bed as far ahead as the wing ends and swim upward to an estimated height of 8-10m, before they turned back to escape over the headline (headline height 4.6m – Table I). Haddock escaped over both the port and starboard wings as well as the headline centre (Plate X) and it was estimated during one haul that 30-40% of the haddock catch was lost (approximately 3000-4000 fish).

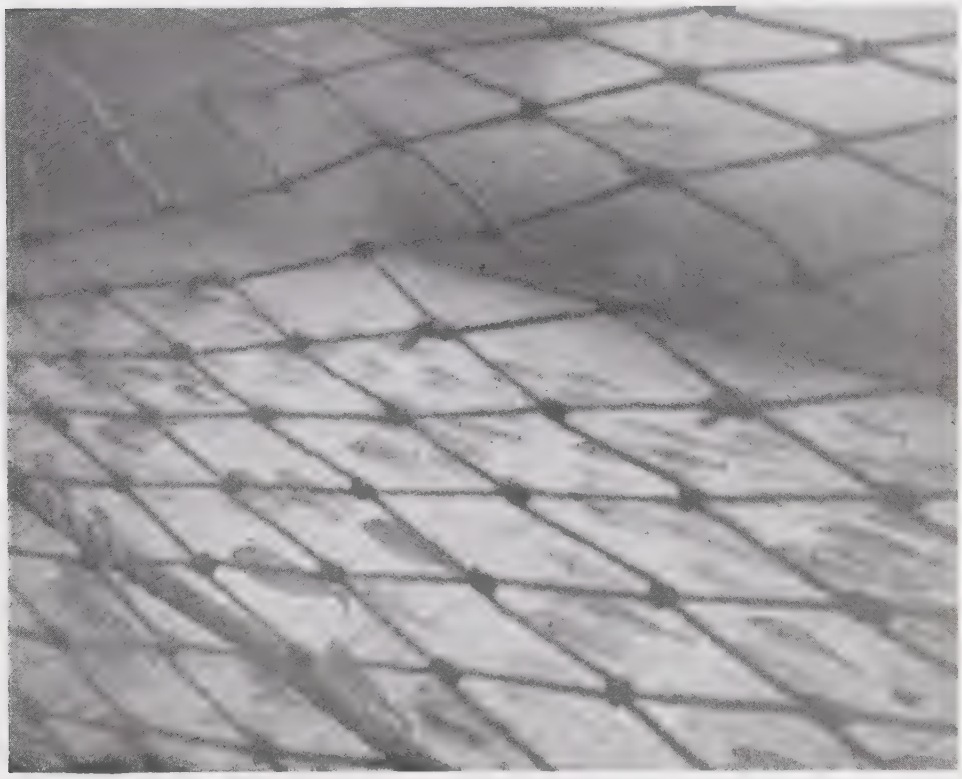


Plate VIII. **Haddock in column formation between the warps of the "Boris Mystic" bobbin trawl.**

Plate IX. **Haddock and saithe swimming ahead of the "Boris Mystic" bobbin groundline. The haddock in the centre of the photograph have risen from the sea bed as they became tired or exhausted, and eventually entered the net 3 or 4m above the bobbins.**

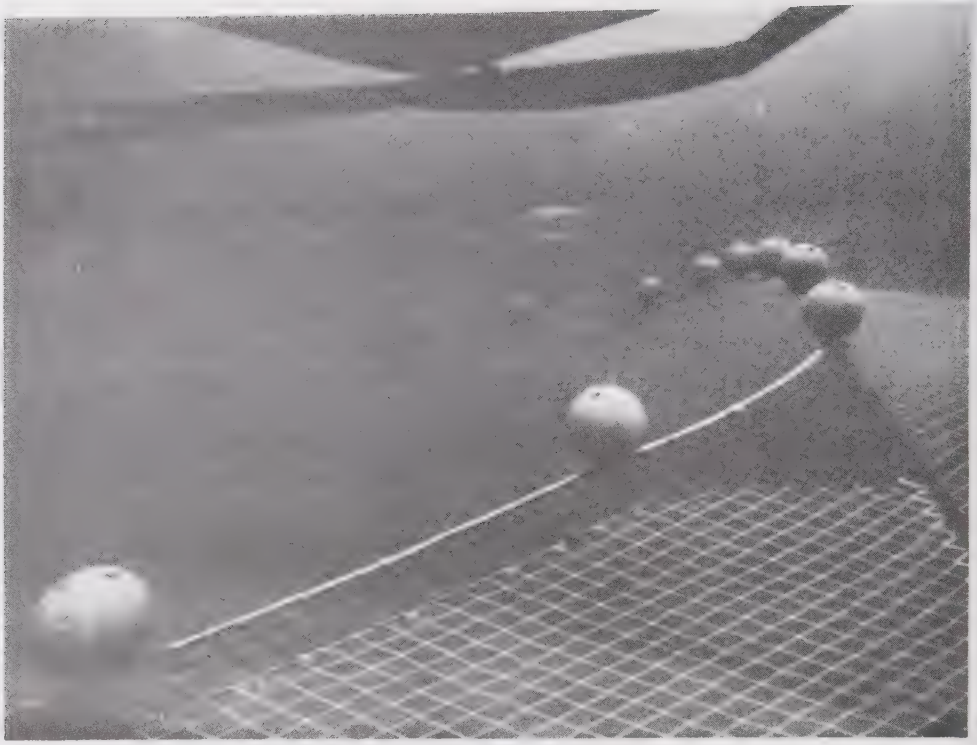


Plate X. A view across the headline of the "Boris Mystic" trawl. Haddock can be seen rising up out of the net mouth, turning and escaping over the headline.

Inside the net, haddock swam forwards using a fast kick and glide action but slowly lost ground and dropped back along the funnel. As with the "Cosalt" net, many saithe turned again 5 or 6m inside the net itself, descended close to the belly panel and then moved forward to the bobbin footrope (Plate XI), using steady tail beat movements, until they again tired and dropped back towards the cod-end.

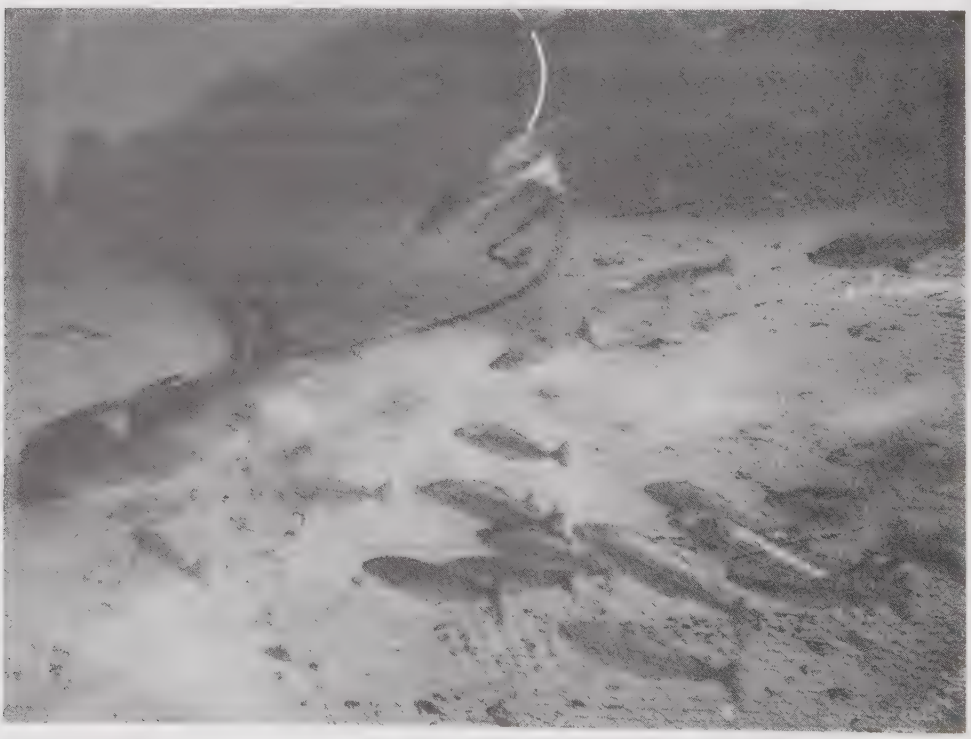


Plate XI. Saithe descending onto the belly panel of the "Boris Mystic" trawl, after having turned 5 or 6m behind the bobbin groundline.

A "flapper" is fitted into the funnel of the "Boris Mystic" trawl to prevent fish escaping from the cod-end in the event of the net stopping, during hauling or coming fast.

At the flapper, all fish panicked as the surrounding netting became more constricted. They maintained the fast tail beat movements and swam with an erratic kick and glide action to try to hold a position ahead of the flapper. Large and small haddock and saithe were squeezed and bumped as they slid and scraped along the flapper panel before entering the cod-end (Plate XII). There was physical damage to all fish passing through this area of the net.

Plate XII. Fish passing along the flapper panel of the "Boris Mystic" trawl. Both large and small fish slid and scraped along the netting before entering the cod end.

The reaction of saithe to the "Boris Mystic" trawl during the "knock out" procedure

In another experiment, 400-500 saithe were swimming in the mouth of the net when the ship was instructed to "knock out" and haul the gear on board in the normal manner. On "knock out", the gear immediately slowed from 1.5 to about 0.25m s^{-1}, and the saithe continued to swim forward at 1.5m s^{-1}. The ship, being a side trawler, towed the gear to starboard and the port board cut across the original path of the trawl. This caused the port side sand cloud to cross the path of the saithe. They stopped swimming, milled around and slowly dispersed. As the sand cloud cleared (after approximately 30 seconds), many of the fish still in this area reformed the school and swam forward again but away from the direction of the obliquely moving gear as it was being hauled back to the ship at approximately 1m s^{-1}. No further observation of this procedure was possible because the net was being winched forward and away from the stationary TUV II. It was estimated that a large proportion of the saithe was lost due to this side trawling "knock out" manoeuvre.

The Speed of Approach of Fish to Both Trawls

When the echosounder recorded marks of fish below the towing vessel the observers in TUV II, positioned at the net, were immediately alerted and

both occupants kept a close lookout for the arrival of these fish at the trawl. It is of interest that each time the divers were alerted (27 times) fish arrived in notable numbers at the mouth of the net. The clock on the video frame and the time of the alert recorded on the audio track on the recorder gave the time taken for the fish below the ship to reach the net (towing speed 1.5m s^{-1}), from which average swimming speeds were calculated. Haddock swam towards the trawls at speeds between 0.2 and 0.4m s^{-1} whereas saithe swam at speeds between 0.7 and 0.85m s^{-1}. No figure was obtained for mackerel. No positive conclusions were drawn as to whether the fish swam at different approach speeds with different trawl gears.

Discussion

Table II summarises the observations made in four areas of each gear, namely the otterboards, half way along the bridles, at the wing ends, and the area immediately ahead of the groundline centre.

Table II

Direct Observation Data on Fish Reaction to Each Gear.

Figures represent observations, not numbers of fish

	"Cosalt" Three Bridle Trawl		"Boris Mystic" Bobbin Trawl	
	Fish swimming towards the gear	Fish seen to turn and swim in the direction of towing	Fish swimming towards the gear	Fish seen to turn and swim in the direction of towing
(a) Otterboards	12	0	17	0
(b) Bridles	15	0	16	0
(c) Wing ends	16	10	8	18
(d) Groundline Centre	34	13	12	37

From the otterboards to the bridles, all fish observed swam directly towards the net. At the wing ends, a greater proportion of fish tended to turn away from the advancing "Boris Mystic" bobbin trawl, than from the lightly rigged "Cosalt" trawl. At the groundline, the majority of fish swam straight back into the "Cosalt" net, whereas the majority turned and swam ahead and away from the bobbin rig.

The TUV II and its towing cable may present an extra visual stimulus to the fish, adding to the stimuli presented by the gear. However, when the vehicle is positioned near to but outside the strongly patterned parts of the gear, such as the otterboards, wings or groundline quarters, it becomes part of a complex visual pattern and probably causes only minor change to the over-all visual stimulus. On no occasion during any of these experiments were fish seen to react to the presence of the vehicle.

The observations suggest that, in daylight, most fish either moved steadily away from the ship in the direction of the trawl or remained in position until movement was triggered by the approaching gear.

Haddock rising and turning either at the wing end area or well ahead of the bobbins have more time to see the gear and escape over the approaching headline than fish swimming very close to or behind the footrope. No haddock escaped over the headline of the lightly rigged net, yet many easily

escaped over that of the bobbin trawl. Would haddock react similarly to the nets during dark fishing? In darkness or in turbid water their reaction might be different because the components of a fishing gear will be seen at much shorter distances; however, Main & Sangster (1982b) reported similarities in the behaviour of haddock during daylight and dark fishing using an experimental three-level trawl.

Why did most fish appear to react differently to the two types of gear? Was it a visual or an acoustic reaction? From Table I, it can be seen that the mouth openings of both trawls are similar in height and width. The netting in each was orange courlene which would provide a similar visible stimulus; to the human eye, however, the bobbin ground gear presented a far greater visual cue than the groundline of the lightly rigged net because of the large black rubber disc bunts and rubber wheel bobbins. Anthony (1981) stated that "contrast perception in cod is as good as, or considerably better than in humans at most of the light levels studied"; our experiments were within these light levels so we assume that what the divers saw, the fish also saw, namely, the very visible bobbin ground gear. However, the noise from the bobbin trawl generated by the chains, shackles and bobbin spacers was very pronounced in comparison to the relatively silent "Cosalt" one. Therefore, sound may have affected the reactions of the fish to these gear; whether this is purely an acoustic reaction, a visual reaction or a combination of both remains unsolved, and affords scope for future investigations.

Summary

Direct observations were made in daylight of the reactions of haddock, saithe and mackerel to two contrasting types of bottom trawl, one with a lightly rigged grass footrope, the other rigged with a heavy bobbin groundline.

Both nets appeared visually similar underwater (depth 20-30m) but the heavy black rubber bobbin groundline was easily seen from as far forward as the wing ends, whilst the light footrope was relatively insignificant.

The light net was virtually silent when fishing whereas the noise from the bobbin trawl could be heard approximately 10m ahead of the wing ends.

Ship noise was heard by the divers both at the otterboards and the net of both trawls.

All fish swam towards both nets in the warp, otterboard, sweep and bridle areas. No fish swam in the towing direction in these areas.

The majority of haddock and saithe tended to swim straight into the lightly rigged net, whereas they turned ahead of the noisy and more visually contrasted bobbin groundline.

Haddock, saithe and mackerel were seen to feed on small sandeels between the wings of both nets.

Haddock swam for no more than 2½ minutes at 1.5m s^{-1} (3 knots) but saithe endured for about 15 minutes at that speed. Mackerel in the mouth of the net increased their swimming speed and avoided capture by swimming straight out of it.

Many haddock escaped over the headline of the bobbin trawl but none escaped from the lightly rigged net. There was physical damage to all sizes of fish in the flapper area of the bobbin trawl.

Direct observation during the side trawling "knock out" procedure showed that a large proportion of saithe escaped during this manoeuvre.

Haddock swam towards the nets at speeds between 0.2 and 0.4m s^{-1} whilst saithe did so at between 0.7 and 0.85m s^{-1}.

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